CARIBOU HABITAT USE ON THE LEVEL MOUNTAIN AND HORSERANCH RANGES, BRITISH COLUMBIA

Ministry of
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and Parks

CARIBOU HABITAT USE

ON THE LEVEL MOUNTAIN AND HORSERANCH RANGES, BRITISH COLUMBIA

by

M.A. Fenger[1], D.S. Eastman[2], C.J. Clement[3], and R.E. Page[4]

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[1]formerly with Terrestrial Studies Branch, presently with Wildlife Branch, Ministry of Environment and Parks, Victoria, B.C.
[2]Wildlife Branch, Ministry of Environment and Parks, Victoria, B.C.
[3]Shearwater Ecological Services Ltd., Victoria, B.C.
[4]Research Branch, Ministry of Forests and Lands, Victoria, B.C.

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PREFACE

An objective of the studies carried out by the Wildlife Branch is to estimate the potential abundance and probable distribution of wildlife habitat available in British Columbia. Such estimates depend on the availability of information concerning wildlife and its use of habitat. In this report the habitat (physical landscape and vegetation) and seasonal use by caribou (Rangifer tarandus) on two separate mountain ranges in northwestern British Columbia is described. The data were collected primarily in 1977-1981 as part of a predation study on caribou.

This report and accompanying maps will have direct application only to those working in northwestern British Columbia; however, they serve as an example of habitat mapping and seasonal use mapping to others who may benefit directly.

The findings of this study and some general steps involved in mapping habitat were presented at a workshop on caribou held at Kamloops on November 5th and 6th, 1985, in a paper by:

Fenger, M.A. (in preparation). Caribou Habitat Mapping in British Columbia. Evolution Towards a Standard Approach.

All papers from this workshop will be available in proceedings to be published jointly by the Ministries of Environment and Forestry.

J.H.C. Walker
Director
Wildlife Branch
B.C. Ministry of Environment
Victoria
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SUMMARY

Two caribou (Rangifer tarandus) ranges in northern British Columbia are described in terms of vegetation, general terrain, soil characteristics, geology, and climate. Vegetation, general terrain, and soil characteristics important to caribou (habitat) were mapped and described at a scale of 1:100 000 for each range (Clement and Fenger 1981a,b). Caribou sightings from caribou census flights (Elliott et al. 1984; Page 1985) are related to various habitat map units. A separate caribou habitat use map (Page and Eastman 1984a,b), which shows areas most heavily used during the rut, calving, post-calving, summer, and winter periods, is presented. The problems of relating caribou sightings to specific habitat types are detailed. Both the Habitat Map and the Seasonal Habitat Use by Caribou Map for each area accompany this report.

The two ranges studied, Level Mountain and Horseranch Range, differed physiographically and geologically. Level Mountain, a shield volcano of alkaline basalt, rises above the surrounding forested lowlands much like an inverted plate. Extensive, gently undulating alpine areas surround the steeper central peaks. Streams that originate from those peaks drain across the plateau in a pinwheel-like fashion. The Horseranch Range is a long, abruptly rising ridge of metasedimentary, coarse-grained bedrock. From this ridge, steep streams flow away from the central axis, forming a pattern much like a fish skeleton. The eastern flank of the Horseranch Range has the gentle, uniform slopes similar to those on Level Mountain. The alpine area is approximately six times larger on Level Mountain than on the Horseranch Range, and of the twelve alpine vegetation landscapes described and mapped, only two are common to both ranges. Consequently, caribou use of alpine habitat during calving, post-calving, summer, and rut differs between the ranges.

Two calving habitats were identified on Level Mountain, one with bog birch (Betula glandulosa)-fescue (Festuca altaica)-dominated vegetation on gently undulating terrain located around the perimeter of the plateau, and the second at higher elevations in sedge (Carex spp.)-dominated vegetation on rubbly, steep slopes, on the central peaks. Only the more rugged area in which the cinquefoil (Potentilla spp.)-dwarf willow (Salix spp.)-mountain heather (Cassiope spp.) fescue (Festuca spp.)-dominated vegetation associated with the central axis was identified as calving habitat on the Horseranch Range.

Post-calving aggregation sites appeared to be in a restricted habitat type, and could represent a limiting habitat factor to caribou. Caribou selected a single, small habitat unit of fescue and bog birch-fescue on shallow moraine during the two years of observations on Level Mountain, and remained within an area of less than 100 ha for a two- to three-week period at a critical time for calf survival (Page 1985). Similar restricted areas were available in only four locations within the Horseranch Range.

Summer range habitat on both study areas was more extensive than calving or post-calving habitat. On both the Horseranch Range and Level Mountain areas, summer range overlapped the areas used for rutting habitat but not calving habitat.

Areas suitable for rutting were considered to be those that provided caribou with a relatively unobstructed line-of-sight to facilitate group interactions. Such open habitat, composed of kobresia (Kobresia myosuroides) -fescue, sedge, sedge-willow, and dwarf willow dominated vegetation on gently undulating areas, was three times as abundant on Level Mountain as on the Horseranch Range. Only the eastern flank of the Horseranch Range provided suitable rutting habitat, with gently undulating, deep moraines that were vegetated by willow-moss, mountain avens (Dryas integrifolia), mountain heather and fescue, provided suitable rutting habitat.

Winter habitat was widely distributed within the boreal forests surrounding both ranges. Mature stands of white spruce (Picea glauca) and lodgepole pine (Pinus contorta) capable of producing lichen appeared to be favoured. Winter habitat apparently was not limiting, although accessibility and availability doubtlessly varied with snow cover.

The key to a better understanding of the use of habitat by caribou and other ungulates will only be achieved when habitat information and animal information are considered in any data gathering program.

To overcome the problems of determining in which habitat types the caribou (wildlife) were sighted, the following are recommended:

1. Animal sightings should be recorded on a national topographic series base, using a system such as that used for winter flying (Demarchi et al. 1983) for accurate geographic locations that can be related to habitat in the future.

2. Successful wildlife censuses must contain observations on the habitats where the animals were sighted to develop a better understanding of habitat use. These observations can be either plotted on habitat maps or noted on tape. Ideally, census observations or radio-collaring observations should be plotted directly onto habitat maps prepared prior to animal census surveys.

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1.0 INTRODUCTION

1.1 Background

The purposes of this report are to describe caribou habitats for two ranges in northern British Columbia, and to evaluate habitat units and seasonal caribou distribution.

This report is an accompanying report to a project initiated to assess the impact of wolf (Canis lupus) predation on the production and survival of caribou. This initial project design called for two ecologically similar, yet geographically distinct study areas (Fig. 1). On the untreated area, the Level Mountain Range, caribou, wolves, and moose (Alces alces andersoni) were monitored but otherwise left undisturbed. On the treatment area, the Horseranch Range, caribou and moose were monitored while wolves were reduced (for details, see Elliott et al. 1984). To assess the ecological similarity between these two areas, habitat maps at a scale of 1:100 000 were prepared for each, consisting of soils, landforms, and vegetation information (Clement and Fenger 1981a, b).

1.2 Objectives

1. Describe and map habitat units (generalized terrain, soils, and vegetation landscapes) for the two study areas.
2. Describe the distribution of caribou in relation to habitat map units used during calving, rut, and late winter.
3. Compare the habitat map units of the two study areas.
4. Compare use by caribou of habitat map units in the two study areas.
5. Produce a caribou habitat use map based on caribou observations.
6. Discuss shortcomings of the approach used to establish caribou habitat use and recommend improvements to others studying caribou and habitat use.

We stress that these results must be regarded as preliminary and tentative, due to the scanty data-base, the low intensity of sampling, and the different scales of recording data. Despite these limitations, we believe the information is useful for an area and species that have received comparatively little previous study. The experience gained and the methods used should be of particular interest to others relating wildlife observations to habitat types and habitat use.

1.3 Study Period

The predation study was conducted primarily from 1977-1981; however, less intensive monitoring of the Horseranch Range caribou and wolves, to follow trends in numbers, has continued to the present. Vegetation, soils, and landscape mapping and site descriptions were collected in the summer of 1980.

1.4 General Description of Areas

1.4.1 The Level Mountain Study Area

The two study areas were initially selected so that no intermixing of caribou between the two areas was likely to occur. The Level Mountain study area is centred 65 km north of Telegraph Creek in northern British Columbia (Fig. 1). The study area approximates the seasonal distribution of the caribou herd that ruts on the mountain, but does not include northerly extensions of the winter range. The Level Mountain plateau covers 3000 km^2 in an oval shape, oriented north-south. The plateau is 70 km by 45 km.

There is no road access to the study area, but the road from Dease Lake to Telegraph Creek approaches within 50 km. A number of lakes around the base of the shield volcano provide float plane access, with Hatin, Granite, and Ketchum Lakes most commonly used. In the southwest of the study area, there is a landing strip at Shesley. The area is also accessible overland by the old Telegraph Trail of 1890's fame. The Trail is still passable to the north through Hatin Lake and beyond the study area. The alpine plateau is easily travelled by horse or on foot during the snow-free period from June to September. The exception is the southern portion where poorly-drained fens make much of this area impassable.

Level Mountain Range caribou are part of a population that ranges west of the Dease River and north of the Stikine River into the Yukon. Caribou collared in 1980 on the Level Mountain Range were found the following winter in the Teslin and Jennings valleys, 120 km to the north. The caribou group that calve on Level Mountain will be referred to by that area name. The home range of the Level Mountain herd overlaps extensively with that of the Kawdy and Jennings Plateaux herds. At high population levels, interchange probably occurs with the Stikine Plateau caribou population herd to the southeast through the Tanzilla Plateau. The Level Mountain caribou range over an area estimated to be five times greater than that of the Horseranch herd.

In 1978, over 400 caribou were counted on Level Mountain but the herd was considered to be declining due to poor recruitment. Calf percentages averaged less than 10%. About 350 caribou were estimated in 1980, though only half that number were actually counted.

Level Mountain is home to many animals other than caribou, including caribou predators. Wolf density was estimated at about 1/100 km^2, and considered to be similar to the initial density of the Horseranch Range (Elliott et al. 1984). Wolf predation is considered to be an instrumental factor in producing the current pattern of caribou habitat use. Wolves were most commonly observed in 1980 in the valleys, but alpine areas were also used for denning and hunting. Grizzly bears (Ursus arctos) were also common in the alpine and are potentially significant predators of newborn caribou calves. Other ungulates included mountain goat (Oreamnus americanus), Stone's sheep, (Ovis dalli stonei), and moose.

The extent and flatness of the alpine on Level Mountain has produced many arctic affinities that are particularly striking in the avifauna. All

Figure 1. Location of the study areas.

three species of ptarmigan (Lagopus mutus, L. lagopus, and L. leucurus) were abundant in 1980. Oldsquaw Ducks (Clangula hyemalis) were frequently sighted in spring and are suspected to be nesting (D. Hatler, pers. comm.). Two Long-tailed Jaegers (Stercorarius longicaudus) were repeatedly seen in the summer of 1980, 1500 km south of their known breeding range.

1.4.2 The Horseranch Range Study Area

The Horseranch Range is located in the Cassiar Mountains, 75 km east of Cassiar in northeastern British Columbia (Fig. 1). The study area boundary approximates the seasonal distribution of the Horseranch caribou herd. The Horseranch Range is a sharply defined physiographic unit, 45 km long and 15 km wide, with its long axis oriented in a north-northwest trend (Holland 1976). The western flank of the range rises steeply from the Dease and Rapid Rivers, at an elevation of 760 m, to 2000 to 2225 m along the ridge crest. The eastern flank has a gentler slope that falls uniformly to the Red River valley at 1050 m.

The study area is accessible by several means. The Stewart-Cassiar road passes 20 km to the west of the area. The Beryl Lake road provides access as far as the west side of the Dease River, a few kilometres from the study area. Pack trails provide access to cabins on lakes at the north and south ends of the range, from which the alpine areas are easily accessible during June to September. These lakes can also be reached by float plane.

The Horseranch Range herd appears to be one of the few in B.C. that is isolated from surrounding populations (J. Elliott, pers. comm.). There are no recorded movements of caribou to the west through the Dease Valley, and no other herds exist to the northeast, in the direction that Horseranch caribou are believed to migrate (Bergerud 1978). There may be interchange of individuals with populations to the south, eliminating genetic isolation, but, in terms of the population dynamics, the Horseranch Range herd is considered discrete.

The herd size was estimated at about 300 in 1980 when the intensive ground work was conducted, and at 350 in 1983. Average age of the herd should be low, consistent with an increasing population size and good juvenile survival. Since 1978, the herd has probably increased at an average of 6% per annum, with 15% calves recorded in October surveys during 1979-81.

Besides caribou, the Horseranch Range supports other large mammals. Mountain goats and Stone's sheep are scarce (<50 of each), and occupy the central alpine peaks. Moose are common in the valleys surrounding the Horseranch Range, but were rarely seen above the tree line. A variety of mammalian predators occur in the area including wolves, coyote (Canis latrans), grizzly and black bears (Ursus americanus), wolverine (Gulo gulo), lynx (Lynx canadensis), and bobcat (L. rufus). Further information on mammals and birds of the Horseranch Range can be found in Elliott et al. (1984) and Page (1985).

2.0 METHODS

2.1 Caribou

2.1.1 Defining a habitat use legend

Seasonal categories of habitat use were based upon general caribou activity patterns, dividing the year into winter, calving, post-calving, summer/fall, and rut. These periods were designed to reflect understanding of shifts in habitat use, so the length of each season is variable (see maps Appendices for definitions).

Seasons chosen were based on the experience of two of the authors (Page and Eastman) with caribou on the study areas (Elliott et al. 1984; Bergerud and Elliot, in press; Bergerud and Page, in press), and experience with other caribou herds in British Columbia, the Northwest Territories, and Ontario. Specific knowledge was far greater for Level Mountain, as 23 radio-collared calves were monitored there as a part of a calf mortality study by Page (1985) during 1980 and 1981.

Characteristics of habitat units (vegetation, soils, and terrain) described for both ranges by Clement and Fenger (1981a,b) were incorporated into the column entitled "General Description of Habitat on the Caribou Use Legend of the maps by Page and Eastman (1984a,b) for each season. The types of habitat units used were determined by plotting animal sightings on maps and overlaying these with habitat maps.

The caribou use units defined for Level Mountain were extrapolated to the Horseranch Range, with modifications due to the different spatial organization of that area.

2.1.2 Census and observations

Most information about caribou habitat use was derived from sightings during aerial surveys conducted by a variety of observers. Spring surveys were flown by helicopter in June to estimate sex and age of the herd, and to measure early calf survival. Fall surveys were conducted in late September or early October coinciding with the rutting period. Winter surveys concentrated mainly on moose and wolf populations; caribou observations were minimal. Locations of all ungulate and wolf observations were recorded on 1:250 000 maps (Elliott et al. 1984).

During ground work in 1980, recent caribou use of a site was determined by direct observation of animals, observation of fecal pellets, and evidence of grazing. Observation of animals on Level Mountain was facilitated by the presence of a number of radio-collared calves that were frequently relocated from the air (Page 1985).

Caribou sightings were assigned to vegetation - landscape units by transferring their estimated locations on the 1:250 000 scale flight record maps to the 1:100 000 scale habitat maps produced by Clement and Fenger (1981a,b).

Since caribou surveys were flown without the prior knowledge that locations would be subsequently related to habitat types, it was not always possible to link a sighting to a specific habitat unit. Some locations on the original flight maps were recorded with a circle, in which case, the centre of the circle was used as the location. Additional information recorded on the flight maps, such as elevation, helped to place sightings more precisely. The error in the location was estimated approximately by recording the number of other map types within 300 m of the point chosen to represent the location. If the number of map polygons into which the caribou observation could be placed was greater than three, the observation was not used. If two polygons occurred within the 300 m circle, the location was assigned to that polygon closest to the circle's centre.

The number of groups of animals and total number of animals in each habitat type in each season were tabulated. The resulting correlations did not meet the assumptions necessary for statistical analysis but provided approximate indications of use.

2.2 Terrain and Soils

The study areas were mapped on 1:60 000 and 1:72 000 scale, black and white aerial photographs, using both Abrahams and Mirror stereoscopes. Changes in tone and surface expression were used to delineate changes in materials and vegetation types. Symbols were placed on the photos using the terrain classification system of the Environment and Land Use (E.L.U.C.) Secretariat (1976) and ecological moisture estimates after Walmsley et al. (1980). Concurrently, a study was made of existing geology reports and maps to increase the mappers' familiarity with the area. Terrain, soil, and vegetation mapping was carried out for the area surrounding the Level Mountain Range in the summer of 1981 and a series of 1:250 000 scale maps were produced by Ryder (1983), Fenger (1984), Rafiq (1983), and Stewart (1985).

Sites were selected to include the largest zonal patterns and units along an elevational gradient. Sites and soils were described using the Ministries of Environment and Forests sampling methods (Walmsley et al. 1980). To verify photointerpretations, approximately 14 days were spent in the field, one week on each range. Six days were spent walking preselected transects and eight days were spent in aerial observations from a helicopter. Twenty-seven site, soils, and vegetation descriptions were collected for the Level Mountain Range, and 25 descriptions for the Horseranch Range. The site, soil, and laboratory analyses were subsequently stored within the B. C. Soil Information system. At selected sites, soils were sampled for soil reaction (pH), organic carbon percent, total nitrogen, pyrophosphate, extractable iron and aluminum, and exchangeable cations.

Field observations recorded on the aerial photos and on site, soil, and vegetation descriptions were incorporated when mapping symbols and boundaries were finalized. Both the vegetation ecologist (C. Clement) and pedologist (M. Fenger) finalized boundaries and unit symbols using a set of Delft stereoscopes. The complexity of the terrain symbols was reduced, and many

landform groups were lumped together to form the generalized terrain legend (see Appendices for examples of these maps).

2.3 Mapping of Vegetation

The overall purpose of the study was to define, map, and describe "vegetation landscapes" and biophysical forest zones. The biophysical forest zones were separated on the basis of differences in climatic climax vegetative cover. Where climatic climax communities were lacking, elevational breaks were used. Vegetation landscapes are areas that are relatively homogeneous with respect to soils, surficial materials, disturbance history, climate, and macro vegetation (Harcombe et al. 1980). To define the vegetation landscapes, a vegetation sampling system was implemented.

Vegetation sampling methods followed Walmsley et al. (1980). Vegetation releves were selected to represent commonly occurring plant communities in typical landscape positions. Other criteria used in site selection included homogeneity, parent material, and soil development. Twenty-seven releves on Level Mountain and twenty-five on the Horseranch Range were described. At each site, all vascular plants, mosses, and lichens were listed. For each plant species, cover was recorded on a 1-4 scale. Unknown plant species were collected and identified at a later time. In addition, voucher specimens of most plant species were collected. A total of 277 vascular plant species were collected from both study areas. Specimens were filed in the Provincial Museum herbarium (Victoria). Once the sampling of vegetation was complete, the vegetation landscapes were tentatively defined. At that time, a helicopter was used to fly a grid pattern over the study areas. During the flight, dominant vegetation landscapes observed were noted on aerial photographs (scale 1:60 000 and 1:72 000).

The mapping of biophysical forest zones and vegetation landscapes was carried out in the office. Zones were mapped using forest cover maps, aerial photographs, and field notes. Where differentiation was difficult, elevation breaks were used. Landscapes were mapped in conjunction with general terrain units on aerial photographs. The process consisted of a joint assessment and agreement of integrated biophysical units (vegetation landscape and general terrain unit). In this way the combined experience of the plant ecologist and pedologist/surficial geologist was used to define the biophysical habitat units.

Description of the zones and landscapes was done in an expanded legend. Zones were defined in terms of elevational range, climatic climax vegetation, brief environmental description, and general climate data. Landscapes were characterized by surficial material, moisture regime, ecological state, stand appearance, and dominant and associated plants. For definition of terms, see habitat maps in Appendices and Clement and Fenger (1981a,b).

Few climatological stations exist north of 55° latitude and of the seven stations operating near the study areas, all but one were located at low elevations. Since climatological data were not specifically available from

the two study areas, estimates of average conditions were interpolated and extrapolated from the few surrounding climatological stations (R. Marsh, pers. comm.; Atmospheric Environment Service 1975; Table 1). These stations were: Atlin, Cassiar, Dease Lake, Lower Post, Telegraph Creek, Teslin, and Watson Lake (Fig. 2).

Table 1. Climate data for the general region including Level Mountain and Horseranch Range study areas

Station	Elev. (m)	1 Mean daily temp. (C)	2 Mean daily max. temp. (C)	3 Mean daily min. temp. (C)	4 No.of days with frost	5 Mean ann. rainfall (mm)	6 Mean ann. snow (cm)	7 Mean ann. total prec. (mm)
Telegraph Cr.	250	2.2	8.0	-3.5	202	-	-	-
Atlin	638	-0.2	4.3	-4.7	218	162	121	283
Teslin	700	-1.6	3.9	-7.0	241	168	164	326
Dease Lake	816	-1.2	4.7	-7.0	244	226	187	394
Cassiar	1077	-3.0	2.7	-8.6	265	292	409	700
Lower Post	583	-2.2	3.6	-8.0	-	-	-	-
Watson Lake	685	-2.9	3.0	-8.7	228	229	227	432

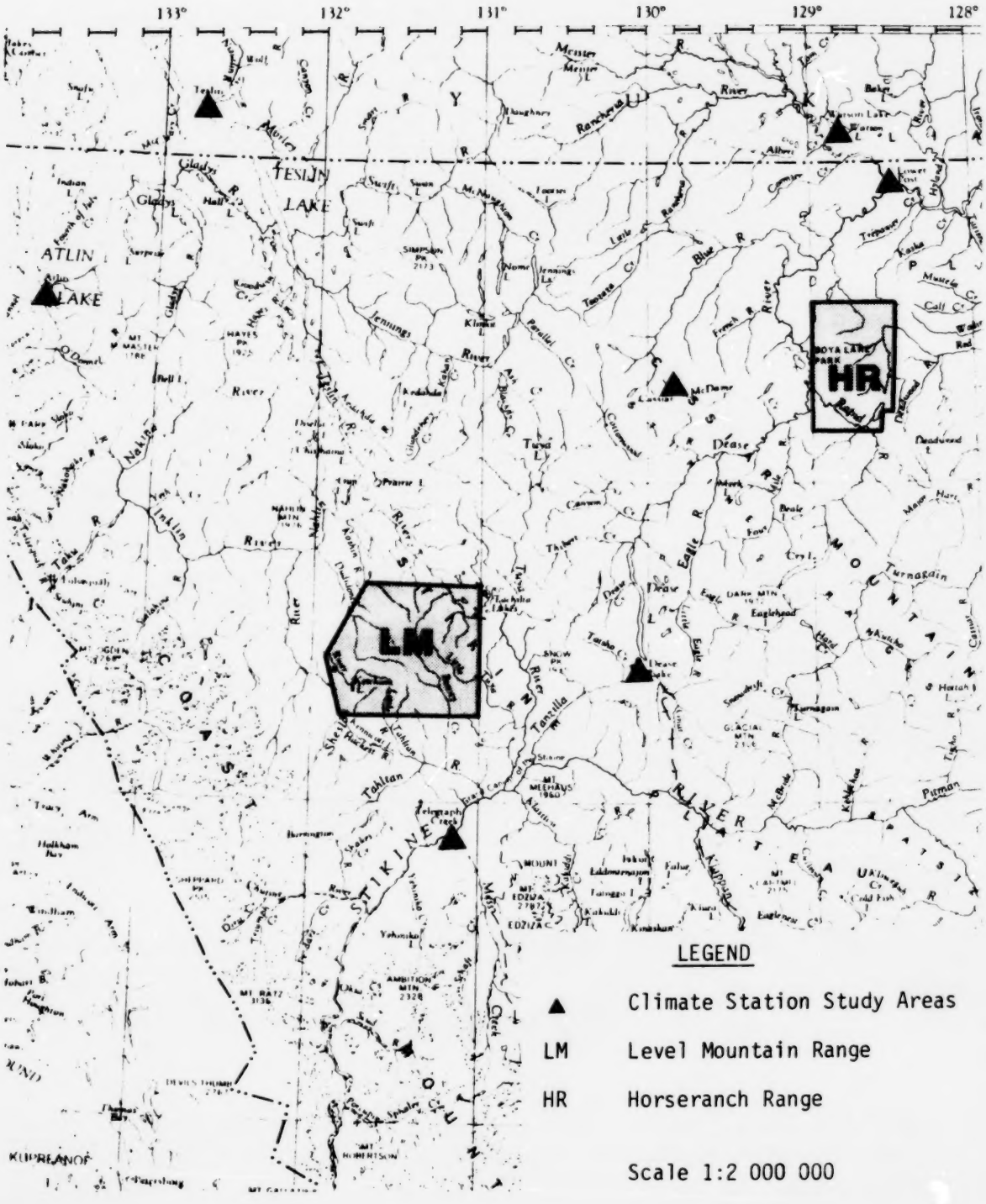

Figure 2. Location of climate stations used to infer climates of the study area.

3.0 DESCRIPTION OF STUDY AREAS

3.1 Level Mountain Range Area

3.1.1 Physiography and geology

The older, erosional surface of the Nahlin plateau surrounding the great shield volcano of Level Mountain lies at an elevation of 900 m. That surface consists mainly of acidic bedrock, as typified by outcrops around Hatin and Granite Lakes (Holland 1976; Gabrielse and Souther 1962). The shield volcano began forming in the late Tertiary and has continued at various periods up until recent times. Thus the plateau portion of the mountain has been built from a series of alkaline lava flows that range in thickness from less than 1 m to more than 10 m, but are typically 2-3 m in thickness (Hamilton and Scarfe 1976).

The plateau surface, from which the mountain has gained its local name, has been glaciated and there are signs that some lava was extruded during periods of glaciation. However, most of the volcano was formed prior to the last continental glaciation (Hamilton and Scarfe 1977). The outer edge of the plateau surface is at about 1200 m rising gently to 1520 m around the central ridges. The ridges rise more steeply to 1980 m. They are the most recently deposited portion of the volcano, and they originate from a series of strata cones and domes. A well-defined but dissected escarpment marks the edge of the plateau on the south and west sides of the range. The older erosional surface of sedimentary bedrock is exposed at lower elevations below the escarpment. The edge of the Level Mountain Plateau is less pronounced on the north and east of the range.

3.1.2 Geomorphology

Glaciation history of this region is not well understood, but glaciation has modified the topography, leaving evidence such as gouging on the north plateau surface. Valley glaciers have dissected the central ridges leaving a radial drainage of streams such as Kaha, Lost, Kakuchuya, Dudidontu, Little Tahltan, and Beatty Creeks in U-shaped alpine valleys. Kakuchuya and Dudidontu Creeks have a series of small lakes, and most valleys, e.g. the eastern tributary of the Little Tahltan, have lateral and terminal moraines. The larger U-shaped valleys, Beatty and Kakuchuya, are cut to a level below that of the plateau surface.

Periglacial processes are active above 1250 m. Cryoturbation (frost heaving), stone striping, and sorting occur even in the lower valley, e.g. near the west side of Ketchum Lake. There are also earthen mounds, similar to pingos, that are 10-15 m across. Cryoturbation is dominant on the level and gently sloping areas, and stones have been sorted into patterns over much of the plateau surface. Stone striping is most common on the gently sloping areas around the central peaks. Solifluction and nivation are confined to some of the moderate slopes of the central peaks. Snow avalanches are restricted to the steepest slopes and around the central peaks.

Mass movements, or landslides, occur around the steep south and west plateau margins. A mudslide of moderate size ($6.0 \times 10^4 m^3$) occurred on the eastern slope of the Little Tahltan canyon. Similar older scars, such as that in Beatty Creek, are visible around much of the perimeter of the plateau. These landslides are a result of relatively clay-rich, incompetent layers of agglomerates and tuffs between more competent basalt flows (Hamilton, pers. comm.).

3.1.3 Soils

Soils studied in the Level Mountain study area can be placed into four groups, based upon the nature of the parent material, landscape position, and physical and chemical properties. That grouping is based on 27 sites visited, eight of which were sampled. This is not a complete listing of soils for the area, since those at lower elevations were not adequately sampled or described. More detailed descriptions of map units (Generalized Terrain) is given on the map legend in Appendix A. (Clement and Fenger 1981b, d, and e).

1. Shallow, coarse, textured, steep to strongly sloping soils of the central peaks (LM8014). Map units C3 and C4.

   These strongly acid, xeric, well drained soils show little or no horizon development. Periglacial processes are constantly at work and soils are churning in place or moving downslope, as indicated by stone stripes. The volcanic bedrock weathers to a granular texture with few fine materials resulting in the coarse textured nature of this soil group with cation exchange capacities of <3 meq./100 g. Soils are classified as Regosols.

2. Soils developed from moraine on the gently undulating alpine portions of Level Mountain (LM8001, LM8016, LM80180). Map units M5, M6, and M7.

   Cryoturbation is the dominant periglacial process affecting this soil group. This process has resulted in patterned ground in which coarse material has been separated from fine material, and vegetated and non-vegetated soils are sharply separated from each other as patches or stripes. Areas stabilized by vegetation show an increase of clay with depth, and resulting higher cation exchange capacities from 15 to 48 meq./100 g. Base saturations range from 9% to 70% in the surface horizon and 13% to 90% in subsurface, clay-enriched horizons. Surface horizons are strongly to very strongly acid, becoming medium to slightly acid at approximately 50 cm in depth. These soils are classified as Brunisolic Gray Luvisols and are continuous within the bog birch zone. At higher elevations, actively churning soils that show no horizons and support no vegetation are classified as Regosols, cryoturbated phase. Seepage areas and imperfectly drained areas have developed an organic matt that rests on the mineral soil. Most of the rooting takes place in that turfy layer.

3. Soils developed at lower elevations on fluvio-glacial materials (LM8012, LM8013). Map unit G1 and G2.

   Base saturation of the sampled sites is above 50% and cation exchange capacities range from 20 to 35 meq./100 g. Many of these fluvio-glacial materials contain a high percentage of fine materials, and soils which have developed from them contain a subsurface horizon enriched by clay accumulation. These soils are classified as Orthic Gray Luvisols. Medium to coarse textured soils, which lack the clay rich layer, are classified as Orthic Eutric Brunisols. Seepage sites and imperfectly drained areas have an organic surface layer, and are classified as Humic Gleysols.

4. Organic soils (LM8028). Map unit O1.

   These very poorly drained soils are extensive on the southern portion of the plateau. The site sampled was used as a lick by ungulates. Calcium and magnesium were present in quantities of 67 and 19 meq./100 g of soil, respectively. Organic soils are confined between granitic bedrock ridges in the area to the north and east of the plateau.

3.1.4 Vegetation

Three Biophysical Forest Zones characterize the vegetation of the level Mountain Range. They are the Boreal White Spruce, Subalpine Fir, and Alpine Tundra. More detailed descriptions of these zones and the vegetation landscapes for this area are given in the map legend in Appendix A (Clement and Fenger 1981 b, d, and e; Rafiq 1983). Biogeoclimatic Zones and Subzones for this area are described by Pojar et al. (1983); fire ecological relationships are described by Parminter (1983).

The Boreal White Spruce Zone surrounds Level Mountain below 1200 m. It has an active fire history. As a result, young lodgepole pine forests and bog birch thickets predominate. Lodgepole pine forms an edaphic climax on sites of coarse gravels. Other plants common under lodgepole pine are bog birch, Altai fescue, kinnikinnick (Arctostaphylos uva-ursi), and mosses. West of the Level Mountain Range, lodgepole pine forests dominate, with bog birch common on intensively burned sites and in valley bottoms. Bog birch thickets are composed of bog birch, willows (Salix spp.), Altai fescue, mosses, and lichens. North of the Level Mountain Range, mature white spruce and lodgepole pine forests predominate, with bog birch occurring in valley bottoms. Under white spruce forests, bog birch, common Labrador tea (Ledum groenlandicum), Altai fescue, mountain cranberry (Vaccinium vitis-idaea), dwarf blueberry (Vaccinium caespitosum), and mosses are common. Scattered throughout the Boreal White Spruce Zone are sedge-willow wetlands, of variable size. Dominant plants include willows, sedges, and mosses (Sphagnum spp. and Tomenthypnum nitens).

The Subalpine Fir Zone, occurring between 1200 and 1540 m, has also been subjected to extensive fires. As a result, bog birch thickets form huge areas of continuous cover. Due to the harsh climate (wind, cold

temperatures, snow, short growing season), the rate of succession is much reduced. In effect, the bog birch communities are a climatic climax. Mature alpine fir forests are confined to the northern slope of the Level Mountain Range, occurring as sporadic stands. Only mosses and lichens are common forest floor plants.

The Alpine Tundra occurs above 1540 m elevation, and dominates the upper plateau of the Level Mountain Range. At lower elevations, bog birch forms low cover (less than 1 m in height) with associated mosses and lichens. As elevation increases and climatic effects become more severe, fescue tundra becomes dominant. The most common plant community in the Alpine Tundra, is composed of Altai fescue, dwarf willows, boreal mugwort (Artemisia arctica subsp. arctica), louseworts (Pedicularis spp.), Arctic bluegrass (Poa arctica), and alpine mosses and lichens. On exposed windswept ridges, kobresia-dominated tundra is common. Dominant plants there include Bellard's kobresia, dwarf willows, Altai fescue, small-awned sedge (Carex microchaeta subsp. microchaeta), and alpine mosses and lichens. The rubbly slopes of the central peaks are sparsely vegetated. Commonly occurring plants are Arctic bluegrass, sedges, dwarf willow, prickly saxifrage (Saxifraga bronchialis), brook saxifrage (Saxifraga rivularis var. flexuosa), moss campion (Silene acaulis), and alpine mosses and lichens.

3.2 Horseranch Range Area

3.2.1 Physiography and geology

Bedrock in the range is mainly sedimentary, but coarse grained granitic and ultrabasic rocks are locally abundant in the north (Gabrielse 1963).

3.2.2 Geomorphology

Numerous cirque basins, which were likely formed prior to the last continental ice advance, occur at the heads of alpine valleys along either side of the range. The cirques are not well defined, the horns and spurs being somewhat rounded, and they contain remarkably little debris (Gabrielse 1963).

During the last major glaciation, ice flowed from south to north over-riding much of the Horseranch Range. The moraines deposited along the lower flanks of the range are calcareous. The source of calcium can be traced to calcareous bedrock types in the Stikine Range farther to the south and west. During glaciation, a series of well-defined, parallel, meltwater channels formed on the eastern flank of the range. The slopes of these channels indicate that meltwater flowed south from the north end of the range and north from the south end of the range, meeting near Johnny Creek on the eastern flank. That glacial meltwater probably cut the canyon on lower Johnny Creek near its confluence with the Red River. A glacial lake formed in the Red River valley. Looncry Lake was dammed by deposits of gravelly, fluvial material at its south end. Horseranch Lake is impounded by a massive complex esker system.

Since deglaciation, periglacial processes such as cryoturbation, and solifluction (E.L.U.C. Secretariat 1976) have been active in the alpine area above 1280 m. Patterned ground and solifluction lobes are common on the east flank of the range. Frost action is most active on north-facing slopes. creating steeper and more unstable slopes than on south-facing slopes.

The study area is within a zone of discontinuous permafrost, however no permafrost was encountered during field work (Brown 1967).

3.2.3 Soils

Soils have been placed into seven groups, depending upon the nature of the parent material, landscape position, and physical and chemical properties. Those groups are based on 25 sites visited, 15 of which were sampled. Consequently, this is not a complete list of soil groups for the area. Specifically, the soils at lower elevations were not adequately sampled or described. More detailed descriptions of mapped units (Generalized Terrain) are given in the map legend in Appendix C (Clement and Fenger 1981 a and c).

1. Shallow (<1 m) soils of the alpine, derived from granitic bedrock of the central ridge of the Horseranch Range (Samples HR8008, HR8013 and HR8017). Map units R1, R2, C5 and C6.

   These medium textured soils have weakly developed horizons. They are situated in upper slope and ridge crest positions, where plant growth is slow and distribution sparse. These soils are very-strongly-to-extremely acid with very low base saturation (<3%) and cation exchange capacities between 8 and 22 meq./100 g of soil. Soils are classified as Orthic Dystric Brunisols and Orthic Regosols (Canadian Soil Survey Committee 1978).

2. Deep soils (<1 m) of the lower alpine; soils derived from morainal materials (HR8010, HR8011, HR8016, HR8021). Map units M5, M6 and M7.

   These gravelly, medium textured soils are very-strongly-to-extremely acid. They are most extensive on the gently sloping, east flank of the Horseranch Range. These soils have deeper, better expressed horizons and are somewhat more fertile than the higher alpine soils. Cation exchange ranges from 4 to 35 meq./100 g and base saturations varied from 2% to 44%.

   These soils are undergoing modification by frost processes such as cryoturbation and solifluction. Much of the eastern flank also receives seepage, and in those areas much of the rooting takes place in a turfy matt of partially decomposed organic matter resting on the mineral soil. The turfy layer has a lower carbon-nitrogen ratio (14:16) than does the mineral soil (18:20), indicating that nitrogen is released at slower rates in the mineral soil. This difference in nitrogen release could be due to the higher soil temperatures in the

turfy matt. These soils are classified as Orthic Dystric Brunisols and Orthic Gleysols, turfy phase.

3. Medium-textured soils developed on fluvial materials within the Boreal White Spruce and Subalpine-Alpine Fir Forest Zones (HR8002, HR8003, HR8022). Minor portions of map unit M3 and C1.

   These medium acid to neutral soils are developed from materials rich in calcium, such as limestone. The exchange sites are dominated by calcium and the base saturations are above 90%. Cation exchange capacity ranges between 5 and 10 meq./100 g. Seepage areas and areas with moderate to imperfect drainage have a buildup of well-decomposed organic humus above the mineral horizon. These soils are classified as Orthic Eutric Brunisols and Humic Gleysols.

4. Coarse textured rapidly drained soils at lower elevations (HR8001, HR8002, HR8005). Map units G1, G2 and E1.

   These neutral soils have developed on the eskers around Horseranch Lake and on the sand dunes west of the Rapid River. They have a very low base saturation (<6%) and an equally low (<6 meq./100 g) exchange capacity, and are classified as Orthic Eutric Brunisols.

5. Medium-textured soils developed on calcareous moraine (HR8023). Map unit M3.

   These mildly alkaline soils have their exchange sites filled (base saturation 100%) with calcium. The well drained soils are classified as Orthic Eutric Brunisols. Cation exchange of the sampled site ranged from 10 at the surface to 8 meq./100g in the subsurface. The morainal soils were poorly sampled and the extent of the medium-textured calcareous moraine is uncertain.

6. Medium textured soils developed from calcareous colluvium (HR8025). Map unit 4.

   These soils are restricted to areas on the western flank of the Horseranch Range, within the Alpine and Subalpine-Alpine Fir zones. These slightly acid soils have their exchange sites filled with calcium and, as a result, have high base saturations. They are classified as Orthic Eutric Brunisols.

7. Very poorly drained organic soils (HR8004). Map unit O1.

   These extremely acid soils have a water table at or near the surface, with tussocks or hummocks of vegetation above the water table. These soils were <1 m in depth, and are classified as Terric Mesic Fibrisols.

3.2.4 Vegetation

The vegetation of the Horseranch Range occurs in three Biophysical Forest Zones: Boreal White Spruce Zone, Subalpine Fir Zone, and Alpine Tundra Zone. More detailed descriptions of these zones and the vegetation landscapes for this area are given in the map legend in Appendix C (Clement and Fenger 1981 a and c.)

In the Boreal White Spruce Zone, which is found below 1200 m, mixed forests of lodgepole pine and white spruce are dominant. Forests are predominantly between 60 and 140+ years old. Lodgepole pine forms an edaphic climax on coarse gravelly soils and on thin soils over rock. Common understory plants include bog birch, Altai fescue, kinnikinnick, mountain cranberry, and lichens. White spruce is the climatic climax species, occurring on fine-textured moraine and colluvium. On mesic sites, common understory plants include black crowberry (Empetrum nigrum), and mosses. On seepage sites, willows, common Labrador tea, mountain cranberry, northern twinflower (Linnaea borealis), and mosses are common. Occurring along poorly drained waterways and associated gravelly terraces are sedge-willow wetlands and bog birch-willow shrub communities. Sedge-willow wetlands are dominated by willows, sedges, and hydrophytic mosses. Commonly occurring plants of the bog birch-willow thickets are bog birch, willows, Altai fescue, mosses, and lichens.

The Subalpine Fir Zone, occurring between 1200 and 1540 m, is composed primarily of mature climatic climax subalpine fir forests and mixed subalpine fir-bog birch communities. Mature forests are composed of subalpine fir (Abies lasiocarpa), with Canadian bunchberry (Cornus canadensis), running club-moss (Lycopodium clavatum), mosses, and lichens.

The Alpine Tundra zone, occurring above 1540 m, is characterized by low willow heaths, patches of xerophytic alpine plants, and small sedge wetlands. On the western slope, dwarf willow communities composed of willows, sedges, mosses, and lichens are dominant. The eastern slope of the Horseranch Range is typically composed of long gentle solifluction slopes. The dominant vegetation on those slopes is made up of willows, small-awned sedge, mosses, and lichens. On exposed windswept knolls, entire-leaved white mountain avens small-awned sedge, locoweeds (Oxytropis spp.), and lichens are common. The central spine of the range, composed of rugged rocky peaks, is sparsely vegetated. On exposed rock slopes and in cirque basins the vegetation is dominated by one-flowered cinquefoil (Potentilla uniflora), alpine woodrushes (Luzula spp.), small-awned sedge, Arctic bluegrass, alpine sweetgrass (Hierochloe alpina subsp. alpina), and mosses.

Both ranges have the same sequence of biophysical forest zones Alpine Tundra, Subalpine Fir, and Boreal White Spruce. Table 2 shows that the subalpine biophysical forest zone has the greatest similarity with all vegetation landscapes described for each range. The alpine areas only had two vegetation landscapes in common.

Table 2. Vegetation landscapes within Biophysical Forest Zones on the Horseranch Range and Level Mountain study areas.

Biophysical Forest Zone[a]	Vegetation Landscapes	
	Horseranch	Level Mountain
Alpine Tundra		bog birch
		bog birch-fescue
	mountain heather-fescue	
	cinquefoil-rock	
	dwarf willow	dwarf willow
		fescue
		kobresia
	mountain avens	
		rubble-bluegrass
		rubble-sedge
	sedge-willow	sedge-willow
	willow-moss	
Subalpine-Alpine Fir	alpine fir-bog birch	alpine fir-bog birch
	alpine fir	alpine fir
	alpine fir-krummholz	alpine fir-krummholz
	bog birch	bog birch
	sedge-willow	sedge-willow
	willow	willow
Boreal White Spruce	bog birch-willow	bog birch-willow
	lodgepole pine	lodgepole pine
	sedge-willow	sedge-willow
	wheatgrass-mugwort	
	white spruce-Labrador tea	
	white spruce	white spruce

[a] More detailed descriptions of Biophysical Forest zones and vegetation landscapes are given on maps in Appendices A and C.

3.3 Climatic Similarities and Differences Between Areas

In British Columbia, the upper atmospheric circulation is dominated by the prevailing westerlies that generally move weather systems west to east from the Pacific Ocean across the Interior. The movement of these migrant pressure systems within the prevailing westerlies and their impingement upon the rugged north-south oriented topography of the province are the most significant climatic controls. Air mass circulation is dominated in winter by cold, high pressure areas over the interior of the continent and, during the summer months, by large semi-permanent high pressure areas over the north Pacific.

The physiography of British Columbia has a great influence upon the regional climates of the province. The Western Cordillera is the most climatically complex region of Canada, where altitude is generally more of a climatic determinant than latitude.

The effect of altitude, topography, and slope on local climates is so dramatic that significant climate variation often occurs within very short distances. Such local factors are likely to mitigate any small effect that latitudinal differences between the two study areas may have.

Long, cold winters and short, cool summers with moderate to light precipitation characterize the region. Outbreaks of polar air may occur any time during the year and, even in the summer months, may lead to freezing temperatures. Poorly drained sites at lower elevations are most susceptible to freezing temperatures under such conditions. Mean January maximum and minimum temperatures over the region are in the order of -17°C and -25°C, respectively. July average regional maximums of 20°C and minimums of 5°C may be expected.

Although the broad regional climatological characteristics of the two study areas are similar, local climates and climatic gradients are probably very different. Geographically, the Level Mountain area is located on the Nahlin Plateau, leeward of the Coast Mountains. Annual precipitation is about 350 mm, of which 55% occurs as snow. The estimated average annual snowfall is 190 cm. The wettest months tend to occur during the summer. Precipitation falling in April is usually snow, while, in May, 60% of the monthly precipitation is rainfall. The Horseranch Range is situated leeward of the Cassiar Mountains. Annual precipitation is estimated to be 450 mm, although more is likely to occur at the higher elevations. Again, 55% of the annual precipitation occurs as snowfall, which represents 248 cm of fresh snow. Only a small percentage of April precipitation occurs as rain, and 70% of that in May is rain.

Relative to the Horseranch Range area, the Level Mountain area is slightly warmer in the winter months, slightly cooler in the summer, and 33% drier throughout the year. Calm conditions are stronger and more frequent. Spring and early summer winds are weaker. The strongest average monthly winds occur from March to June, while in the Horseranch Range the stronger winds occur from April to July.

Level Mountain dominates the Nahlin Plateau, but is a gently sloped, unwooded area with a net altitudinal reach of only 750 m. Because of its flatness the area has subtle aspect differences between sites, particularly at the low to upper-mid elevations. Hence a relatively homogeneous climate extends over the area, with only gradual temperature and precipitation gradients occurring altitudinally. The gently sloped lands have reduced air drainage and, on clear, calm nights, have lower minimum temperatures and therefore a reduced frost-free period in the summer. Although wind speeds in the Level Mountain area increase with increasing elevation, the distribution of wind over the area is fairly uniform. During the late-May/early-June calving season, winds predominate from a southerly quadrant (65%). Calm conditions are infrequent and average monthly windspeeds are on the order of 3-4 m/sec. At 1370 m, there is a 15-20% chance that precipitation will occur as snow; that probability increases with altitude. Mixed rain and snow are common at that time of year.

The Horseranch Range study area is topographically dissimilar to the Level Mountain area. The range stands sharply above the rest of the Dease Plateau, and reaches 1440 m above the Dease River Valley. Mountain slopes are steep and aspects are sharply defined. Sites with a southern to southwestern exposure receive considerably more solar radiation than do northern and northeastern exposures, and that results in considerable differences in the thermal characteristics of local and, on occasion, adjacent sites. At low elevations, temperatures are more extreme with higher daytime maximums, and, particularly under inversion conditions, lower minimums. A steep thermal gradient occurs with altitude, while more subtle gradients are present between southwest-facing and northeast-facing slopes. Similarly, precipitation gradients are present, with significant changes attributable to exposure and elevation. The greatest precipitation occurs on the upper west-facing slopes. A local precipitation rain shadow probably exists on the mid and lower east-facing slopes.

Because of the steepness of the topography, air drainage is better than at comparable altitudes in the Level Mountain area. In summer, minimum temperatures are probably slightly higher. During the calving season, winds predominate in either a northwesterly or southeasterly direction, although there is great local variation due to the rugged topography. Windspeeds are greater than those in the Level Mountain area, and may average 3.5 m/sec at low elevations and 6 m/sec at higher elevations. A high frequency of calm conditions occurs throughout the year (25%), although only 10-13% occurs during the calving season.

No comparative snow depth data are available for the study areas. Level Mountain receives less snowfall, but the gentle topography and reduced wind speeds encourage a greater relative accumulation of snow. In the Horseranch Range, greater amounts of snowfall occur, but the steeply inclined slopes, higher wind speeds, and the topographically more complex exposure to sun and wind lead to a highly variable distribution of snow cover, and a great variability in snow depths. High elevation, steeply inclined slopes will have reduced snow cover, and in many cases may be swept clear of snow. West-facing slopes have less snow than east-facing slopes even though they may receive more snowfall. Local winds lead to deep accumulation of snow in

sheltered and shaded locations on most slopes. The greatest snow accumulation is on mid-elevation north-facing and east-facing aspects. At the present time, no information is available on the temporal distribution of snow cover in the two areas.

In summary, the low, gently sloping relief of the Level Mountain area is characterized by a more uniform climate, with only subtle changes in local climates below 1670 m. Consequently, large mammals do not have a wide diversity of local climates from which to choose. Travel from high to low elevations below 1700 m may be difficult for some mammals, due to the accumulation of snow. Above 1700 m, steeper slopes and an improved exposure to local winds will clear ridges of snow. In contrast, the Horseranch Range is topographically diverse and climatically variable. Large mammals are provided a wide choice of local climates from which to choose. Over short distances, warm, cool, sheltered, exposed, sunny, shady, moist, or dry local sites can be chosen. Exposed ridges and slopes should also provide the opportunity for unimpeded movement from lowland forests to the unwooded uplands.

4.0 DISCUSSION OF CARIBOU OBSERVATIONS AND THE EVALUATION OF HABITAT USE ON THE LEVEL MOUNTAIN RANGE

The evaluation of caribou observations to habitat is restricted to the Level Mountain Range because better locations for observations enabled better correlation to the habitat units than on the Horseranch Range.

Sixteen flights over Level Mountain, primarily in the calving and rutting seasons, recorded 1623 observations of caribou in 198 groups (Table 3). Group size ranged from 1-104, and varied seasonally. The mean group size was largest during the rut (26) and smallest during calving (5). The single winter survey indicated a group size intermediate between the other seasons. In late calving and early summer, caribou would be expected to have large group size during the formation of the post-calving aggregation. During a calving survey on 1978 June 18, this aggregation had begun and the mean group size was 22.

We also had additional accurate geographic locations for calving habitat, post-calving habitat, and summer habitat due to the radio collaring of calves and their subsequent relocation by radio telemetry. These locations were obtained by Page (1985) while working on caribou calf mortality.

Caribou come together in concentrations to perform some activities such as rutting and calving but whether the same animals are present one year to the next is presently unknown. This had implications in choosing the size and location of the study areas initially, as intermixing of groups between study areas would confuse any changes in population. The barrier effect of the Stikine Ranges of the Cassiar Mountains and the distance separating the treatments was considered to ensure a low likelihood of population exchange between the two study areas. Some general similarities exist in caribou use of habitat between the two areas. Alpine areas are used for calving, post-calving, summer, and rut activities; the boreal forest is used for wintering areas.

On Level Mountain, caribou appeared to use two habitats for calving; one with bog birch-fescue dominated vegetation on gently undulating terrain around the perimeter of the plateau, and the second at higher elevations in sedge-dominated vegetation on rubbly, strongly to steeply sloping, rugged areas of the central peaks. The presence of snow on the plateau surface surrounding the central peaks was thought to result in more calving at low elevations in some years. The extensive, gently undulating alpine areas were not available within the Horseranch Range, and calving was thought to occur only at the higher elevations in the more rugged areas in which cinquefoil, dwarf willow, mountain heather, and fescue dominated the vegetation. On Level Mountain, caribou were most widely dispersed during the calving season (Tables 4 and 5). A total of 734 animals were seen in 156 groups in 39 habitat units. As can be seen from these observations, most groups were small in size. Although widely distributed, 61% of the groups were in five map units.

Table 3. Survey flights for the Level Mountain Range.

Flight No.	Date	No. animals	No. groups	Average group size
RUT				
1	Oct. 06/78	33	3	11
2	Oct. 11/78	282	13	22
3	Oct. 21/79	180	6	30
4	Sept. 27/80	165	6	28
5	Oct. 21/81	75	1	75
6	Oct. 13/81	108	3	36
Rut Total		843	32	26.34
WINTER				
7	Jan. 13/79	27	2	13.5
CALVING				
8	June 18/78	243	11	22
9	June 02/80	36	11	3
10	June 04/80	60	23	3
11	June 05/80	78	27	5
12	June 07/80	100	21	5
13	June 08/80	27	7	4
14	June 10/80	113	30	4
15	June 09/80	93	31	3
16	June 10/81	3	3	1
Calving Total		753	164	4.6
Total		1623	198	8.2

Table 4. Percent distribution of caribou sighted on Level Mountain, by habitat units by season (This table is extracted from data presented in Table 5.)

Habitat unit[a]	Total number of caribou seen (%)			
	Rut	Winter	Calving	Total
1. AB-BB/M4			1	<1
2. AF-SW/M1		11	<1	<1
3. BB/C3			<1	<1
4. BB/M7			2	1
5. BB-FE/M5	2		3	2
6. BB-SW/M5	3		3	3
7. BB-AB/G			<1	<1
8. BB-AB/M5			1	<1
9. BB-DW/C4			<1	<1
10. BB-FE/M5 or M7	2			
11. BF-SW/M7			3	1
12. BW-SW/M2		89		2
13. DW-RS/RS			<1	<1
14. FE/M5	5		<1	3
15. FE/R2			1	<1
16. FE-SW/M5	37		11	25
17. FE-BF/M5			1	<1
18. FE-DW/M7	15		2	8
19. FE-BF/M5	<1			<1
20. FE-BB/M5 or M7	7		4	4
21. FE-BB-M5	1		<1	<1
22. KO-SW/M5	2		1	2
23. KO-SW/R2			3	1
24. KO-RS/M3	2		7	4
25. KO-RS/R2	24		4	14
26. KO-BF/M5	<1		21	10
27. LP1/BE/M1			<1	<1
28. RB/C4			<1	<1
29. RB/R1			2	1
30. RS/C4			1	<1
31. RS/RS			1	1
32. RS-BF/C4			1	1
33. RS-RB/C4			4	2
34. RS-DW/R1			<1	<1
35. RS-RB/C3-C4			13	6
36. RS-RB/G2			1	<1
37. RS-RB/R1			9	4
38. RS-BB/M6			<1	<1
39. RS-RB/C2			<1	<1
40. SW/F1			<1	<1
41. WI-SW/M5			<1	<1
42. WL-AB/M5			<1	<1
No. of units	13	2	39	42

[a] Proportions of plant communities in each unit are omitted in this table for the sake of clarity. Generally the first community occupies 60% of the unit. The latter portion of the habitat unit symbol refer to generalized terrain within the unit. Definitions of map symbols are given in the Legend attached to the Habitat map.

Table 5. Summary of observations of caribou groups for all surveys for habitat units on the Level Mountain Range.[a]

Habitat units	Season	RUT 6 survey flights observ. (caribou)	RUT 6 survey flights % caribou	WINTER 1 survey flight observ. (caribou)	WINTER 1 survey flight % caribou	CALVING 9 survey flights observ. (caribou)	CALVING 9 survey flights % caribou	TOTAL 16 survey flights observations (caribou) /all seasons
1.	AB-BB/M4	-	-	-	-	3 (7)	1%	3 (7)
2.	AF-SW/M1	-	-	1 (3)	11%	-	-	1 (3)
3.	BB/C3	-	-	-	-	1 (2)	<1%	1 (2)
4.	BB/M7	-	-	-	-	3 (12)	2%	3 (12)
5.	BB-FE/M5	2 (16)	2%	-	-	11 (22)	3%	13 (38)
6.	BB-SW/M5	2 (26)	3%	-	-	6 (17)	3%	8 (43)
7.	BB-AB/G	-	-	-	-	1 (1)	<1%	1 (1)
8.	BB-AB/M5	-	-	-	-	3 (6)	1%	3 (6)
9.	BB-DW/C4	-	-	-	-	1 (2)	<1%	1 (2)
10.	BB-FE/M5 or M7	-	-	-	-	8 (15)	2%	8 (15)
11.	BF-SW/M7	-	-	-	-	5 (19)	3%	5 (19)
12.	BW-SW/M2	-	-	1 (24)	89%	-	-	1 (24)
13.	DW-RS/RS	-	-	-	-	2 (4)	<1%	2 (4)
14.	FE/M5	1 (42)	5%	-	-	1 (3)	<1%	2 (45)
15.	FE/R2	-	-	-	-	1 (6)	1%	1 (6)
16.	FE-SW/M5	5 (308)	37%	-	-	3 (83)	11%	8 (391)
17.	FE-BF/M5	-	-	-	-	2 (4)	1%	2 (4)
18.	FE-DW/M7	6 (169)	20%	-	-	3 (15)	2%	9 (184)
19.	FE-BF/M5	1 (3)	<1%	-	-	-	-	1 (3)
20.	FE-BB/M5 or M7	2 (54)	7%	-	-	1 (2)	<1%	3 (56)
21.	FE-BB-M5	1 (6)	1%	-	-	1 (1)	<1%	2 (7)
22.	KO-SW/M5	2 (13)	2%	-	-	4 (8)	1%	6 (21)
23.	KO-SW/R2	-	-	-	-	5 (19)	3%	5 (19)
24.	KO-RS/M3	1 (12)	2%	-	-	13 (64)	8%	14 (76)
25.	KO-RS/R2	7 (185)	24%	-	-	7 (28)	4%	14 (213)
26.	KO-BF/M5	1 (2)				14 (157)	21%	15 (159)
27.	LP1/BE/M1	-	-	-	-	2 (4)	<1%	2 (4)
28.	RB/C4	-	-	-	-	1 (6)	<1%	1 (6)
29.	RB/R1	-	-	-	-	2 (12)	2%	2 (12)
30.	RS/C4	-	-	-	-	1 (6)	1%	1 (6)
31.	RS/RS	-	-	-	-	1 (9)	1%	1 (9)
32.	RS-BF/C4	-	-	-	-	4 (9)	1%	4 (9)
33.	RS-RB/C4	-	-	-	-	7 (30)	4%	7 (30)
34.	RS-DW/R1	-	-	-	-	1 (2)	<1%	1 (2)
35.	RS-RB/C3-C4	-	-	-	-	20 (99)	13%	20 (99)
36.	RS-RB/G2	-	-	-	-	3 (7)	1%	3 (7)
37.	RS-RB/R1	-	-			16 (7)	9%	16 (67)
38.	RS-BB/M6	-	-	-	-	1 (4)	<1%	1 (4)
39.	RS-RB/C2	-	-	-	-	2 (4)	<1%	2 (4)
40.	SW/F1	-	-	-	-	2 (4)	<1%	2 (4)
41.	W1-SW/M5	1 (7)	1%	-	-	1 (1)	<1%	1 (1)
42.	WL-AB/M5	-	-	-	-	1 (1)	<1%	1 (1)
TOTALS		32 (843)		2 (27)		164 (753)		198 (1623)
No. of Units Used		13		2		39		42

[a] The table assumes that all habitat units were searched equally each survey flight. The first number represents the number of times that caribou were counted in the habitat unit, the second number is the number of animals counted, for example unit 35 had 99 caribou seen in 20 different locations on 9 flights.

These calving map units had several interesting features. Twenty-two percent were in high elevation, sparsely vegetated, steep slopes developed on colluvium. Twenty-eight percent were in kobresia-dominated plant communities characteristic of exposed ridges at low to middle elevation. Eleven percent were in plant communities dominated by altai fescue that occurred on gently to moderately sloping morainal veneers.

Post-calving sites were the most restricted in size. The caribou appeared to use only a portion of a habitat unit and remained within an area estimated to be less than 100 ha for about a two- to three-week period. The logic of this tactic was postulated to be predator swamping. It is conceivable that if the same area of kobresia and rubbly-sedge was used on Level Mountain each year, it could be a limiting habitat factor to caribou population growth. Heavy grazing could result from repeated prolonged use of such a restricted area.

Summer caribou habitat on the Level Mountain Range appeared to overlap with the rutting areas but excluded the areas used for calving and post-calving. Since the alpine area on Level Mountain (116 400 ha) is approximately six times as extensive as on Horseranch (19 400 ha), it is possible that the caribou on the Horseranch Range were forced to use all sites to obtain the same amount of forage.

Rutting areas on the Level Mountain Range were estimated to be four times as extensive as those on the Horseranch Range. Rutting habitat was thought to be determined by physical landscape characteristics within the alpine. Good visibility was considered to be the key factor in determining rutting areas. In the rut, six surveys were made from 1978-1981 (Table 3). Of the 843 caribou sighted, 74% were recorded in three habitat units (Tables 4 and 5). These units supported low growing plant communities dominated by Altai fescue, dwarf willows, sedges, and Bellard's kobresia. The habitat units were level to gently sloping (0-15%), and were comprised either of morainal veneers and blankets over bedrock, or rubbly bedrock outcrops interspersed with ground moraine.

Winter observations were scanty (Tables 4 and 5). During the mid-winter survey, most (89%) of the 27 caribou sighted were assigned to a community of bog birch, willow, and sedge, growing on gentle to moderate morainal blankets. The remaining caribou were observed in a predominantly subalpine fir forest interspersed with willow/sedge communities, located on gentle to moderate morainal veneer. Based on other data (Page 1985; D.Hatler, pers. comm.), it is assumed that most of the Level Mountain caribou spend the early to mid-winter period in primarily forested habitats to the north and west of the main study area. Radio-telemetry data from the nearby Spatsizi caribou also support this interpretation (Hatler 1983). Observations in the upper Stikine River valley in March 1981 indicate that by late winter, most caribou move upslope out of the alpine forests onto the windswept alpine slopes (Fuhr and Demarchi 1982).

Despite scanty observations, winter habitat was considered to be widely distributed within the boreal forests surrounding both ranges. It was not possible to include all the areas used by caribou within the study area

boundaries. Generally it is believed that lichen associated with mature stands of spruce and lodgepole pine play an important role in the caribou diet. Since the caribou are widely distributed in winter, and habitat did not appear limiting in extent, little effort was spent to characterize this type of habitat.

Much of the choice of habitat by caribou appeared to be related to non-vegetation factors such as topography, presence of permanent snow patches, areas of good visibility for rutting, and rugged areas to provide escape cover for calving.

5.0 RECOMMENDATIONS

This study contributes to the understanding of caribou and their use of habitat but it would have benefitted from more accurately located census observations and from records of habitat types used by caribou at the time of census flights. Difficulties were encountered because of the method of recording observations during the census work. The original intention was to use caribou observations from census work to build an understanding of population dynamics and interactions with predators - not to quantify seasonal habitat use. Consequently, most observations were not specific about what types of habitat the caribou used and all observations were only marked on 1:250 000 scale maps. The precision of these locations was often inadequate when the location maps were overlaid with the habitat map: there was, in some locations, uncertainty as to which habitat unit the caribou were in. Caribou sightings were often related to specific elevations that were not always exact as ground elevation was determined by subtracting the estimated height of the aircraft above ground from the aircraft altimeter. Consequently, it was possible to accurately place caribou into habitat units only in very large uniform habitat units.

Three ways of overcoming the problem of determining the location of caribou and quantifying the habitat used are recommended. These recommendations are considered to be equally applicable to all studies that link animal observations to habitat use.

1. Censuses should include observations on habitat to improve our understanding of habitat use. This recommendation requires observers who could identify habitat types as accurately as possible while also collecting census information. If the habitat and wildlife use of habitat is to be quantified, then standard habitat types should be agreed upon prior to census work. This is especially true if comparisons are to be made using observations recorded by different observers on different flights. The number of classes of habitat recognized determines the level to which habitat use can be described, for example if only alpine and non-alpine habitat types are consistently recorded, then future analysis will be limited to only these two classes.

2. Accurate locations of animal sightings on a map base, using a system such as that outlined for winter flying (Demarchi et al. 1983), is the minimum standard for recording wildlife observations. Using this system, a map is created for each census flight with a standard set of symbols for animals observed, track abundance, and snow depths, along the flight path followed. This map, although only one point in time, becomes a historical document of future importance as it is part of a standardized data-base showing geographic distribution. The flight line location is as important as the animal locations along it as it shows areas that have been searched but are without animals. When quantifying habitat use, it is necessary to search all areas equally in order to build a habitat use model. For example, if observations are only recorded on wetlands then it is not possible to compare the use of these to the habitat types between wetlands.

The scale of the map on which the observations are made and the precision with which these are located will determine, to a large extent, the future level of detail that can be quantified regarding habitat use. If, for example, census information is recorded on topographic maps at scales of 1:250 000, then the habitat units that can been delineated are restricted to habitat maps of this same scale.

3. Accurate locations of animal sightings recorded directly on a habitat map base using a system such as that outlined for winter flying (Demarchi et al. 1983) is the optimum method quantifying habitat use. Placing observations directly on a habitat map eliminates the uncertainly that was experienced by transferring topographically related observations to habitat units at a later date. A habitat map also provides a standard set of units and definitions against which animal observations can be analysed. This means habitat mapping and classification work should precede census work. This approach is not without problems as it assumes that all the important habitat characteristics are known in advance. Some unidentified, important habitat, can be added to the map after the census work. This is a minor problem compared with using only topographic maps as a base.

   By recording census information on topographic maps, elevation/aspect/slope models only can be built, but, by recording census information on habitat maps, a vegetation/site model for caribou could be built.

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APPENDICES

A Wildlife Habitat Map (Generalized Terrain and Vegetation Landscapes) for the Level Mountain Range ([a] 1:100 000 scale map; Clement and Fenger, 1981 b) also available at 1:50 000 scale from Maps B.C. (Clement and Fenger 1981 d and e).

B Seasonal Habitat Use by Caribou on the Level Mountain Range ([a] 1:100 000 scale map, Page and Eastman, 1984a).

C Wildlife Habitat Map (Generalized Terrain and Vegetation Landscapes) for the Horseranch Range ([a] 1:100 000 scale map, Clement and Fenger 1981a) also available at 1:50 000 scale from Maps B.C. (Clement and Fenger 1981c).

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